TRENDS and RESPONSES

A

Forest Health Report

1850-1992

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TRENDS AND RESPONSES:A FOREST HEALTH REPORT
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The condition of New Hampshire's forest resources has had its up and downs during the last 400 years. We are told the American Indian was the only human factor affecting this land when the first European arrived. Forests of mammoth pines stretched as far as the eye could see, according to the explorers Martin Pring, Samuel de Champlain and Captain John Smith (Cullen 1987). Before the arrival of the Europeans, the eastern half of the United States was predominantly forested. These forests generally covered more than 80 percent of the land (Millers 1989). New Hampshire alone was 90 percent forestland (Cullen 1987).

Seventy percent of the southern New Hampshire forest resource was removed by 1850 as the cutting of mast trees, lumbering and clearing the land for farming occurred (Cullen 1987). In 1867, a sale of State lands opened up the White Mountains and northern New Hampshire forestlands to the forest industries (Cullen 1987). The adoption of the railroad to transport heavy loads of lumber and timber from remote areas to commercial centers further aided the stripping of New Hampshire's forest resource (Cullen 1987). The intrusion of steam engines combined with the abundance of logging slash, led to extensive forest fires. New Hampshire's forestland was reduced to an estimated 48 percent of the State's total land area by the mid-1800's (Ober 1992).

The next 40 to 50 years saw the basic forest industry attitude begin to change from supplying timber for sawmills to one of providing forests for a pulpwood industry. Unlike timbering, a pulp industry requires an investment in site, power, water sources, buildings, specialized equipment, and a large forest base (Holbrook 1968). Near the close of the nineteenth century public concern, devastating forest fires, politicians, the Gifford Pinchots and others, began to advocate a new forest ethic. In the Northeast, this ethic took several forms; forest conservation, forest preservation, forest management, and multiple use. As a result, the New Hampshire Forestry Commission, formed in 1893, was given fire control as its main charge, however a few short years later, its charge was broadened to include multiple use as well. Other supporters of multiple use of the forest resource included the Berlin Mills paper company which employed Austin Gary in 1895 as the first industrial forester, the Society for the Protection of New Hampshire Forests in 1901, and later in 1911 the passage of the Week's Law (Holbrook 1968). Recovery of New Hampshire's forest resource had begun. After a low of 48 percent in the mid-1800's by 1925, 65 percent of the total land area had become forest cover (Ober 1992).

In many people's minds, the thought of forest protection continued to mean protection from fire. Events such as the finding of Chestnut Blight in New York City in 1904 (Metcalf 1913) and White Pine Blister Rust infections in southern New Hampshire in 1910 (Report of the NH Forestry Commission 1909-10), brought many foresters, legislators and the public to realize the meaning of forest protection included forest insects and diseases. The Chestnut Blight Disease loss estimate, just seven years after the disease was recognized, was placed at $25,000,000 and it had not yet spread into the chestnut timber of the Southern Appalachians (Metcalf 1913). The American Chestnut as a commercial tree species has disappeared from its natural range in the Northeast, Appalachian region and Ohio Valley - only stump sprouts survive today (Harlow 1950).

White Pine Blister Rust is an equally lethal disease on white pine. The initial pine infection occurs through a live needle, eventually progressing into bark tissue. This time delay between needle infection and eventual girdling of the main stem caused the highest rate of tree mortality to occur on young white pine saplings and seedlings. Fortunately, White Pine Blister Rust offered a significant control opportunity not found with Chestnut Blight; the need for an alternate host, Ribes. In New Hampshire, 57 years of Ribes eradication has largely eliminated most of the currant and gooseberry bushes near our white pine forest types. Today White Pine Blister Rust no longer constitutes a major disease problem in the Northeast (Benedict 1966). Before the White Pine Blister Rust program, foresters gave little thought to forest insects and diseases, they thought solely in terms of protecting forests from fire. Blister Rust changed that (Benedict 1966).

Forest insect and disease specialists have continued to broaden their concern with investigations and assessments of natural and anthropomorphic stresses on our forest resources. Ozone and acid rain effects upon our hardwood and coniferous forests have extended this role as part of today's forest management team. Now that role has enlarged again to include a usable indicator of the health of the forest resource. This index or indicator is to reflect the comparative vigor of the forest at a moment in time with a future moment. In other words, what is the condition of our forests' health?

The focus of this report is the condition of New Hampshire's forest resource, a brief introduction to the factors which have affected it and the actions the Division of Forests and Lands has taken to protect and enhance that resource with a major emphasis on forest pests.

This resource is composed of eight major forest types. They are: White Pine/Red Pine/Hemlock,Spruce/Fir,HardPine,Oak/Pine, Oak/Hickory,Elm/Ash/RedMaple,Beech/Birch/Maple and Aspen/Birch. The percentage of forest area in each major type is illustrated in Figure 1 of the appendix.

The forest pests which have occurred are discussed in the forest type which they most prefer or are most important in. Some damaging agents will attack, to a lesser degree, components of many

forest types (Fig.3). New Hampshire's forest types have the advantage of being very mixed, there are no great expanses of one single pure species. The forest type areas appear like islands surrounded by other forest types (Fig.2). This diversity is an important mechanism for protection from specific destructive agents. A pest can be very successful at damaging a particular forest type, but is unable to expand into other areas, due to the buffer-like nature of an unsuitable forest type. This mechanism attempts to keep outbreaks contained and is a factor in how forest pests affect New Hampshire's forest resource.

WHITE PINE/RED PINE/HEMLOCK

Eastern white pine is one of the most valued trees in New Hampshire, both commercially for lumber, christmas trees and landscaping, and non-commercially for wildlife habitat and natural beauty. White pine is a pioneer species, which means it seeds into areas such as grassy fields left by abandoned farms or burned areas, before competing climax tree species have a chance to become established.

Red pine is used primarily for post, poles and pulpwood. Fossil records indicate red pine is a very old species. During periods of glaciation, red pine migrated south and then returned north with the retreat of the glaciers (Rudolf 1990).

The white pine/red pine/hemlock type is the second largest group in New Hampshire forests. Currently, the state of New Hampshire has 1,356,000 acres total of this type. Although it is found scattered throughout New Hampshire, the majority, 75% (1,015,700 ac.), is found in the southern half of the state.

The white pine/red pine/hemlock forest type is generally found on well drained, sandy soils of low to medium quality.

The white pine/red pine/hemlock group represents forests in which white pine, red pine, or hemlock, singly or in combination, comprises a plurality of the stocking. Common associates are red maple, sugar maple, oak, aspen, red spruce, balsam fir and paper birch.

Many insects and diseases have been important in the white pine/red pine/hemlock forest type. The two most serious threats to white pine in New Hampshire are White Pine Blister Rust and the White Pine Weevil.

White Pine Blister Rust is an introduced fungus which girdles the branches and trunk of white pine, eventually leading to tree mortality. White Pine Blister Rust requires gooseberry or currents (Ribes) as an alternate host in order to successfully infect white pine. White Pine Blister Rust was first found in New Hampshire in 1910. By 1925, 214 out of 235 towns and cities contained white pine mortality caused by this fatal disease (Anonymous 1925).

In the spring of 1918 the Division of Forests and Lands began an eradication program for ribes in cooperation with towns, cities, and landowners in the state. The White Pine Blister Rust Eradication program was very successful at suppressing ribes in the state. The program was suspended in 1975.

White Pine Blister Rust is still present in New Hampshire and continues to cause mortality. Today Blister Rust's greatest threat is to areas of white pine reproduction where residual Ribes are present. Rust spores given off by the infected bushes can easily reach the live branches of seedling-sapling size-class white pine and significantly reduce the per acre stocking level. Its presence is not a limiting factor in the management of white pine.

Another serious enemy of eastern white pine is the White Pine Weevil. This native insect attacks and kills the terminal shoot of white pine causing losses in height growth and disfigurement to the tree.

A 1952 field study conducted in New Hampshire on white pine and the merchantable volume loss due to the White Pine Weevil, indicated sizable losses which reduced the production capability of white pine. The percent loss of potential merchantable volume in pole-timber trees (5.0"-8.9" dbh) was 35 million cubic feet or 450,000 cords, 2.16 billion board feet in sawlog portion of saw-timber (9.0" dbh and up) and 116 million cubic feet or 1,485,000 cords for material other than sawlogs (Waters 1955).

In 1973 a monitoring survey was set up to determine the locations and extent of White Pine Weevil activity. The intensive monitoring continued for the next few years and then ceased. Losses to White Pine Weevil still occur because no economically feasible controls for forest application have been developed.

White pine can be very sensitive to Ozone damage and high levels of Ozone cause needle blight and tip burn. This type of air pollution was suspected of causing damage to white pine foliage periodically over the years.

In 1974 the first year of a study of air pollution effects on white pine in New Hampshire began, two sites, Boscawen and Madbury were involved. In 1976 a site in Belmont was added, this was the final year of the study.

During the summers of 1974-1976, oxidant levels at these three sites in NH were found to be sufficiently high and prolonged, causing damage to susceptible pine.

Since 1976 Ozone damage has occurred occasionally in different areas. The most recent, a winter Ozone fumigation, occurred early in 1992 in Thornton and affected approximately 40 acres.

Red pine has fewer pest problems associated with it than white pine in New Hampshire. One damaging agent that affects both red and white pine in this forest type is Annosus Root Rot. Annosus Root Rot has primarily been a problem in thinned pine stands, on well-drained, deep, sandy soils. The first collection in NH was June 1918 in North Conway. In 1930 it was found on white pine in Peterborough. Prior to 1959, Annosus Root Rot had been found on red pine in New Hampshire in only two other localities, Fox Forest in Hillsborough and at Honey Brook State Forest in Marlow (Miller

1960). During the 1959 field season, 14 areas infected with Annosus were located, and in 1967, six additional areas were found. The survey focused on red pine plantations, but other areas were checked. Most of the infected sites were in the southern portion of NH.

The control methods for Annosus Root Rot include chemical treatment of the freshly cut stump with urea or borax, or biological control using Peniophora gigantea, a common sap-rotting and antagonist fungus to Annosus Root Rot.

The most important pest problem on hemlock in NH has been the Hemlock Looper, Lambdina athasaria(Walker), the "spring-flying" Hemlock Looper. Three distinct outbreaks have been recorded, all occurring in southern New Hampshire. In the 1949-50 period a high percentage of trees died in New Boston and Peterborough. As a result of heavy infestations in Deering and Peterborough during the second outbreak year, a cooperative aerial spraying project was successfully completed. An intensive ground survey in 1950-51 indicated no further damage was detected (Anonymous 1951).

A second reported Hemlock Looper outbreak occurred in Moultonboro and Tuftonboro in 1964 and hemlock mortality was reported on Little Bear Island, in Lake Winnipesaukee. A single, low volume application of malathion by helicopter in 1965 prevented any further hemlock mortality. A detection survey conducted in cooperation with the N.H. Department of Agriculture found 80% of the hemlock in a 100 acre area had been killed on this island (King 1965). The aerial application on approximately 500 acres of shoreline and islands was credited with removing the core looper population and greatly assisting the further collapse of the outbreak.

Annual monitoring surveys for Hemlock Looper, Lambdina athasaria (Walker), were conducted until 1977 without finding other outbreak areas. The "spring-flying" Hemlock Looper was not detected again until 1990. Significant defoliation was found on Long Island in the Center Harbor township and in Winchester. In 1991 the Long Island infestation collapsed, however, the Winchester outbreak continued to expand with 3,920 acres of heavy defoliation in thirteen townships. This latest outbreak initiated a tri-state, Maine, New Hampshire, Vermont, impact survey to study the effect of Hemlock Looper on the hemlock resource. Salvage cutting to remove severely weakened or recently killed hemlock tree is continuing. Aerial spraying is being held in reserve until loggers selling hemlock have saturated the hemlock market and/or the outbreak continues to expand and intensify.

Currently, NH is being threatened by another enemy of hemlock, the Hemlock Woolly Adelgid. Although this insect has not yet been found in NH, survey sites have been monitored annually since 1988. With assistance from the 10 county foresters, the monitoring sites were doubled in 1992.

Hemlock also receives some damage from Gypsy Moth, Hemlock Borer and drought stress. Other less damaging agents occurring in the white pine/red pine type in NH are armellaria mellea, a shoestring rot on white pine, salt damage on white pine and Red Pine Sawfly on red pine.

SPRUCE/FIR

There are a total of 677,600 acres of spruce/fir type in New Hampshire, 95% (644,100 ac.) in the northern three counties, with scattered pockets south to the border with Massachusetts. In the White Mountains, balsam fir is the predominant species above 4000 feet, but red spruce is well represented from 2,600 - 3,300 feet (Blum 1990).

In New Hampshire, the spruce/fir type can be found on two types of soils. Red spruce and balsam fir grow best in well-drained soils, with a high water holding capacity and a thick layer of humus. This soil type is characteristic of areas with abundant rainfall and coniferous forests. However, red spruce is predominantly found in high elevations on exposed poor sites because these sites are less favorable for its competitors (Weiss 1984).

The forest type spruce/fir represents those forests in which red, white, black and Norway spruce, balsam fir, northern white cedar, tamarack, or planted larch, singly or in combination, comprise a plurality of the stocking. Common associates are white pine, red maple, yellow birch, paper birch, aspen, hemlock and sugar maple.

Red spruce is used in paper production and construction lumber. Black spruce, balsam fir and northern white cedar are important as wildlife habitat. Black spruce is important to spruce grouse for cover and food. Balsam fir is the main tree species used for christmas trees and wreaths. Northern white cedar is popular for fencing.

The major stressors which have been important in the spruce/fir type causing extensive mortality and dieback are the European Spruce Sawfly and the Spruce Budworm.

The European Spruce Sawfly was first observed in NH on Mt. Washington in 1929. The first and only major outbreak occurred in 1937, in Dublin on Mt. Monadnock; 300 acres were involved. The defoliation, to what was believed to be the finest spruce sawtimber in the northeast, prompted immediate action by the Division of Forests and Lands, the US Forest Service and the Society for the Protection of New Hampshire Forest. In response the area was surveyed by autogyro and sawfly parasites were released in great numbers into the infestation. The Microplectron parasite, which kills European Spruce Sawfly in the cocoon, became established and killed appreciable numbers. However, the real demise of the

European Spruce Sawfly came in the 1940's from an accidentally introduced nucleopolyhedris virus, a larval disease.

The European Spruce Sawfly is well distributed throughout NH, but established parasites and the widespread virus have kept the sawfly population at levels where European Spruce Sawfly is no longer considered an economic pest.

The most important damaging pest in the spruce/fir type in NH history has been the Spruce Budworm. This insect prefers balsam fir, but to a lesser degree will feed on red spruce, white spruce and occasionally black spruce. Spruce Budworm has been monitored in NH since 1974, when there was a massive inflight of moths from Canada (Boivin 1981). Aerial surveys of the northern portion of the state were conducted every year from 1974 to 1981 for SBW defoliation.

Aerial Survey and Acres Defoliated by SBW

	YEAR	ACRES
	1975	14,300
	1976	106,000
	1977	110,000
	1978	70,000
	1979	70,000
	1980	40,000
	1981	40,000
Acres recorded from ground	1982	39,000
	1983	5,765
	1984	800

After 1981 the SBW population decreased to a non-threatening level and the aerial survey was discontinued for that specific insect. Later in the 1980's, lack of funding and staff limitations prevented the aerial survey of SBW annually, however, an aerial survey of the northern spruce/fir type is planned for the 1992 field season.

Other monitoring activities for SBW have included pheromone trapping of the adult moths, larval and egg surveys.

Changes observed in high elevation stands of red spruce and balsam fir in NH during the 1930's and 1940's were thought to relate to climate change (Weiss 1984). Due to increased concern over the red spruce and balsam fir resources, NH and the USFS-Forest Pest Management staff, along with Vermont and New York, conducted a survey from July 1984 to January 1985, to determine the extent of tree mortality over the range of the spruce/fir type. The Cooperative Survey of Red Spruce and Balsam Fir found the percent

of spruce-fir slope type in each mortality class for NH was:

CLASS	PERCENT	ACRES
Light	42	73,400
Moderate	15	25,600
Heavy	43	76,300

This mortality is the result of such factors as competition and chronic insect and disease damage. It was assumed that up to 10% standing dead trees represents a normal forest condition (Weiss 1984).

Factors reported as causing damage and mortality in high elevation spruce/fir stands were wind, ice and snow, winter desiccation, drought, overmaturity and fluctuations in the water level.

At the lower elevations, factors were drought, winter desiccation, Spruce Beetle (on spruce <10"dbh), root disease and fluctuation in water level. Air pollution and changes in climate have been related to tree mortality at high and low elevations (Weiss 1984).

A brief history of mortality in Spruce/Fir type in NH from the Cooperative Survey of Red Spruce and Balsam Fir is as follows:

1840 - extensive spruce mortality near Newport; the Spruce Beetle is suspected

1890-1900 - Spruce Beetle outbreak from Maine extends into northern New Hampshire and kills large red spruce

1910 - Spruce Budworm outbreak

1962-1968 - 30,000 acres over this time period affected by winter kill, high winds, ice, extreme cold and drought

1968 - Winter injury caused browning on spruce and fir on 15,000 acres

1970 - Dead and dying balsam fir attributed to Balsam Woolly Adelgid which was delineated by aerial survey in 1965

1975 - Spruce Budworm outbreak; balsam fir mortality

1976 - Bands of dead balsam fir observed at higher elevations of presidential range; discovered to be a normal and continuous regeneration process

1978 - Spruce and fir mortality attributed to drought, old age and poor site; small isolated pockets of fir killed by Balsam Woolly Adelgid

1980 - Eastern Dwarf Mistletoe found to occur on red spruce and cause growth loss, butt-log degradation and mortality; most prevalent on trees of 100 years old or more

1984 - 63,500 acres of spruce and fir with average mortality exceeding 10% mapped aerially,SBW caused; Spruce Budworm caused mortality continuing in northern Coos County

HARD PINE

The hard pine type is found on shallow depth, sandy soils. It grows mostly in less fertile soils, which makes its distribution spotty. There are a total of 41,700 acres of the hard pine type in NH, 65% is found in Carroll County, mostly around the area of Ossipee Lake.

Special uses for pitch pine include timbers in mine construction, fencing and railroad ties. As the common name implies, pitch pine is very resinous, this makes it a desirable species for ship building; it has coarse grain, moderate strength and its resinous characteristic makes it resistant to decay. In New Hampshire, sites being used for industrial parks or recreation are commonly found in this type.

Pitch pine is also very important as a food source to wildlife. Seeds shed in winter are food for squirrels, quail and small birds like the black capped chickadee. The cones remain on the tree unopened for many years or until heat from a forest fire opens them.

Eastern redcedar is less common and not as important commercially as pitch pine, but serves as food and shelter for wildlife. Unlike pitch pine, the worst enemy of eastern redcedar is fire. This is because eastern redcedar has thin bark and a shallow root system which makes it susceptible to excessive heat.

The hard pine type represents forests in which pitch pine, or eastern redcedar, singly or in combination, comprise a plurality of the stocking. Common associates are white pine, paper birch, sugar maple, basswood, oak and hickory.

The hard pine type in New Hampshire has received little attention concerning insect or disease problems. This forest type is a very small component of our forests and has little timber importance in New Hampshire. The hard pine type has been attacked

periodically by the Pine Needleminer, but has fair resistance even to heavy insect feeding. In New Hampshire, this feeding has been observed in the sandy plains near Ossipee Lake and in the Concord Heights area. Due to changing land use such as development and recreation, this forest type is becoming an even smaller component of New Hampshire's forest.

OAK/PINE

The oak/pine type represents forests in which hardwood (usually hickory or oak) comprise a plurality of the stocking, but where white pine or eastern redcedar comprises 25% to 50% of the stocking. Common associates are beech and sugar maple.

Oak/pine represents a transitional stage of the successional pattern from a predominantly pine dominated forest to the climax forest types dominated by oaks and other hardwoods (Graney 1983).

Oak/pine is scattered in pockets mostly throughout the southern portion of New Hampshire, there are 99,900 acres of this type in the state.

The major oak species found within this type in NH are white, northern red, black, scarlet and chestnut oak. All oak acorns are very important to various birds and mammals. Northern red oak and black oak are highly valued lumber species and red oak is frequently planted as an ornamental tree in yards and parks. White oak is commonly used for staves in barrel making. Scarlet oak, in addition to its value as a timber and wildlife species, is also a popular ornamental due to its brilliant red color, open crown texture and rapid growth. The major pine associated with the oak/pine type in New Hampshire is pitch pine.

In New Hampshire, the most serious pest of the oak/pine type has been the Gypsy Moth, which defoliates oaks and white pine. Gypsy Moth, however, is primarily a problem in the oak/hickory type.

OAK/HICKORY

There are a total of 395,200 acres of oak/hickory type in New Hampshire. It ranges from Haverhill and Woodstock south to the border with Massachusetts. This cosmopolitan type is found on all topographic positions from dry rocky ridges to well drained valley floors in moderately moist, well drained and loose textured soils.

Hickories in New Hampshire include pignut,shagbark, and bitternut. Hickory species are most desirable for charcoal, fuelwood and lumber. Hickories also provide food for many animals including squirrels, chipmunks, turkey and songbirds.

Black locust is used for fence posts, mine timbers, boxes and crates. Black locust is also widely planted in the United States for erosion control and reclamation of drastically disturbed sites.

Yellow poplar lumber is used in furniture making and is an ornamental in yards and parks due to its attractive shape and distinctive flowers.

Oak/hickory represents forests in which upland oaks, hickory, yellow poplar, black locust, sweetgum, or red maple(when associated with central hardwoods), singly or in combination, comprise a plurality of the stocking, and in which hard pines or eastern redcedar comprises less than 25% of the stocking. Common associates are white ash, sugar maple, hemlock, white pine, paper birch, beech, balsam fir, poplar and elm.

Many understory trees and shrubs occur in this forest type including dogwood, sassafras, serviceberry(shadbush), and witch hazel.

The most important pest in this forest type is the Gypsy Moth, an introduced defoliator which came to the U.S. through Massachusetts in 1864.

Records of Gypsy Moth defoliating oak, beech and other tree species in NH have been kept since 1924, when 591 acres were defoliated. Gypsy Moth outbreaks are generally cyclical and last between 7 and 10 years; there have been roughly 7 outbreaks of Gypsy Moth since the early 20's. The worst outbreak occurred in 1981 when 1,947,206 acres in NH were defoliated. There have been many years with no official defoliation recorded. Repeated heavy defoliation of oak reduces the growth potential and causes twig, branch and occasionally tree mortality.

Survey methods for this insect include pheromone trapping of male moths, eggmass counts and viability testing and aerial flights to map the extent and intensity of the defoliation. The Division of Forests and Lands has flown the state for Gypsy Moth defoliation yearly since 1982.

Acres Defoliated by GM: 1980-1991

YEAR	TOTAL ACRES DEFOLIATED
1991	211,450
1990	133,450
1989	18,400
1988	1,015
1987	290
1986	0
1985	0
1984	0
1983	560
1982	983,705
1981	1,947,206
1980	183,999

The pheromone trapping occurs at 72 sites throughout the oak/hickory type and is used to indicate trends in moth populations.

Control efforts for Gypsy Moth have included advising home and land owners on tree banding, maintaining tree health and pesticide treatments. The Division has coordinated and participated in aerial applications of Bt, a biological pesticide, and Sevin for Gypsy Moth.

There have been periodic outbreaks of Oak Leaf Tier in the oak/hickory type. Oak Leaf Tier is monitored yearly by pheromone trapping, egg surveys and aerial examination of the area threatened by this insect.

The oak/hickory type has also received damage from Chestnut Blight which decimated the chestnut trees in NH's forests. Another less damaging, but always present, insect in this type has been the Fall Webworm. Fall Webworm is ordinarily of no great importance as a forest pest since it usually attacks understory weed species of no economical value (USDA 1985).

The Fall Webworm creates unsightly webs which encompass the tree branches they feed on. Although the webs detract from the appearance of the trees, Fall Webworm is not usually damaging to the tree. One reason for this is the fact that Fall Webworm feeds on the leaves in the late summer or fall. At this point in the season, the tree production has slowed in anticipation of winter dormancy and the loss of leaves to insect feeding is not as shocking to the tree as if defoliation occurred during the peak growing season. Fall Webworm is more often a serious pest of shade and ornamental trees.

A disease which has affected the understory of this type has been Dogwood Anthracnose. Dogwood Anthracnose was first reported on dogwood in NH in 1988, areas with the infection were New Castle and Hampton.

Drought has also played a role in affecting declines in the oak/hickory type. Drought in combination with Gypsy Moth defoliation has caused additional stresses on this forest type.

ELM/ASH/RED MAPLE

This forest type is scattered from one end of the state to the other, with 52% found in the northern half and 48% occurring in the southern half. Despite the area it covers, the elm/ash/red maple type is the smallest of the major forest type groups found in New Hampshire, covering 32,200 acres.

This type is found mainly along river valleys in New Hampshire and is commonly referred to as lowland or bottomland hardwood. It usually occupies moist to wet muck or shallow peat soils. All three species are moderately tolerant of shade (Eyre 1980). Before the advent of Dutch Elm Disease, american elm was a prized street tree. This was because of its graceful "wine glass" shape and large shading crown.

White ash, in the early days, was thought to provide protection from snake bites, so hunters would put ash leaves in their pockets and boots (Schlesinger 1990). White ash seeds are eaten by wood duck, bob white and fox squirrel.

Black ash wood is very popular for basket making. Green ash has strength, hardness, and shock resistance which makes it the favored wood for baseball bats and axe handles.

The elm/ash/maple type represents those forests in which elm, willow, cottonwood, black ash, or red maple(when growing on a wet site), singly or in combination, comprise a plurality of the stocking. Common associates are white ash, sugar maple, aspen, oaks, balsam fir, northern white cedar,beech, white pine, silver maple and basswood.

The elm/ash/red maple forest type has endured little in the way of major forest pests or disease problems. This forest type is the smallest component in NH's forests which contributes to the minor disease and insect activity.

The most significant disease associated with this forest type has been Dutch Elm Disease. This disease is more recognized as an urban tree problem, rather than a forest problem and has eliminated american elm as an important timber and shade tree in New Hampshire and throughout it's range.

Some other minor damaging agents have been Ash Decline, Gypsy Moth and Nectria canker on red maple.

BEECH/BIRCH/MAPLE

The beech/birch/maple forest type is commonly referred to as the northern hardwoods. This forest type is the largest represented in New Hampshire with 2,003,600 acres.

This type is found mostly on loamy, well drained soils. Repeated wildfires, cutting, and past land use have created numerous combinations of stand conditions, age class and tree species (Jacobs 1983).

Sugar maple is the principle source of sap for the production of maple syrup. Beech is important for its mast (nuts) which provides food to a variety of birds and mammals. Beech wood is used in furniture, flooring, veneer and plywood. Yellow birch lumber and veneer are used in making furniture, paneling and cabinets.

The beech/birch/maple type represents forests in which sugar maple, american beech, yellow birch, black cherry, or red maple(when associated with northern hardwoods), singly or in combination, comprise a plurality of the stocking. Common associates are white ash, hemlock, basswood, aspen, red oak, balsam fir, red spruce, paper birch, sweet birch, white birch, white pine, and elm.

This forest type provides the brilliant and rich fall coloration admired by many.

The northern hardwood forest type has had many insect and disease stressors which have caused serious decline or mortality. This type is the largest component of New Hampshire's forest and the tree species in it are economically important.

One insect which has been important in this type is Saddled Prominent, an insect which predominantly prefers sugar maple, beech, and white birch, but readily feeds on yellow birch and red oak. Saddled Prominent, as a caterpillar, feeds on the leaves of northern hardwoods and has a distinctive marking on it's back which resembles a saddle.

Saddled Prominent was first noted in NH in 1911, but little was recorded about the insect and it was forgotten. Then in 1969 larvae were discovered in the Madison, Eaton, Conway and Freedom area, about 40,000 acres were defoliated. In 1970 Saddled Prominent spread over the Ossipee Mountains and into Grafton and Sullivan Counties, defoliation estimates now reached 400,000 acres. In 1971 over 600,000 acres were defoliated, the population "crashed" and Saddled Prominent disappeared.

In 1980, monitoring work indicated an increase in the Saddled Prominent population signalling the beginning of a new infestation. This outbreak defoliated 514,100 acres and collapsed in 1982. Saddled Prominent larvae can be found occasionally today, but not at epidemic levels.

During the late 1970's and throughout the 1980's there was a concern by sugarbush managers and foresters who manage in northern hardwoods about sugar maple decline; particularly in relation to air pollution and management intensity. A program designed to monitor and evaluate sugar maples was started between Canada and the United States. The North American Sugar Maple Decline Project (NAMP) began in 1987 and monitoring continues today in New Hampshire.

There are six plot-clusters in NH, three in managed sugarbushes and three in non-managed northern hardwood type. Sugar maples are rated according to percent crown dieback, transparency(amount of light coming through the crown), leaf size and evidence of tapping among other indicators.

Conclusions from the data collected between 1988 and 1990 indicate that overall sugar maple conditions have improved. Other observations made from data collected were that sugar maple health is similar between sugarbushes and unmanaged stands and that sulfate wet deposition (acid rain) seems to have had no major effect on sugar maples in the sample areas. Adverse effects on sugar maple crowns were apparent from insect defoliation and drought (Millers 1992). The NAMP plots will be revisited and remeasured during July/August of this year.

Another major problem in the northern hardwood forest type is Beech Bark Disease, a complex agent which involves an insect and a fungus. Introduced from Europe, the Beech Scale insect infests american beech in NH, feeding on and killing patches of the bark. A fungus, Nectria coccinea, which is entirely dependent upon the scale for its incidence and spread, enters the ruptured bark around the dead area. The fungus penetrates the cambium and sapwood,

killing tissue and interfering with the trees ability to conduct and store nutrients. This process leaves a forest of cankered and worthless beech trees and can eventually lead to mortality.

A Bruce Spanworm outbreak on sugar maple, beech and poplar occurred during 1983 and 1984 in northern Grafton and Coos County. At the peak outbreak year 17,600 acres were moderately to heavily defoliated. Many areas of moderate to heavy twig dieback and moderate tree decline were evident on sugar maple and beech. No tree mortality was reported.

Other insects that have periodically been important in the Beech/Birch/Maple type are Pear Thrips on sugar maple, Gypsy Moth, Sugar Maple Borer, Cherry Scallop Shell Moth and Black Knot on black cherry.

ASPEN/BIRCH

The aspen/birch type forest is aesthetically appealing due to the light colored bark and attractive fall foliage. Aspen/birch is a pioneer type and is very adaptable to disturbed sites. It is the prime hardwood species type which revegetates areas of drastic disturbance such as gravel pits. These tree species grow rapidly but do not live long. They tend to be found on floodplains and well drained sandy upland loams.

This type represents forests in which aspen, paper, gray birch, and pin cherry, alone or in combination, comprise a plurality of the stocking. Common associates are red maple, poplar, white pine, red oak, white ash, balsam fir, red spruce, and white spruce. This type group is comprised of the pioneer forest types that revegetate abandoned farms and areas disturbed by fire.

Bigtooth and trembling aspen have soft colored wood used mostly for paper pulp and flake board. Aspen makes good sauna benches and playground sets because the wood surface does not splinter.

The aspen/birch type is very important to a variety of wildlife needs. The aspen forest is habitat for ruffed grouse, the aspen leaves and staminate flower buds provide ruffed grouse with their most important year long food source. Aspen and birch is browsed by moose and deer; it is also a favorite of beaver. Young aspen forests are used by black bear, woodcock and a number of small birds.

Paper birch is often planted as an ornamental because of its graceful form and attractive white bark.

Pin cherry is sometimes called fire cherry indicating its value as a reforesting agent after forest fires. Pin cherry is highly valuable to many bird species and various other animals, but is of little commercial value.

A variety of pests will affect the aspen/birch type. Those which have received attention from the Division of Forests and Lands are Forest Tent Caterpillar, Gypsy Moth and Bruce Spanworm.

Others which are observed, but have not warranted survey or intensive monitoring efforts are Hypoxylon canker, Bronze Birch Borer and Birch Leafminer.

FOREST HEALTH

In 1986 and 1987, the Division of Forests and Lands undertook a state-wide survey to ascertain the decline condition of our hardwood forest resource. The New Hampshire Hardwood Decline Survey based the plot locations on a grid system which produced sixty stands south of the White Mountain National Forest, plus thirty-one stands north of the WMNF. Size classes contained 17% saplings, 58% pole and 25% of sawtimber. Each of the 2,181 trees sampled were rated in five classes. These index classes ranged from healthy to dead based on the amount of branch dieback, foliage color, foliage size, evidence of mechanical, forest pest and weather damage. Results showed twenty-three percent (21 stands) were rated as healthy with little or no adverse stress factors present. Sixty-five percent (59 stands) appeared to be under stress which affected their normal growth patterns. A small number, twelve percent (11 stands) of those surveyed, showed severe stress and/or contained a few dead hardwood trees.

Selected Tree Species Ratings[1]
All Size Classes
(Sapling,Pole,Sawtimber)

SPECIES	PERCENT RATED INDEX		
	Healthy	Sickly	Dead
Sugar Maple	57%	31%	2%
Red Oak	31%	35%	5%
Red Maple	49%	33%	2%
Paper Birch	63%	21%	6%
American Beech	72%	18%	0%

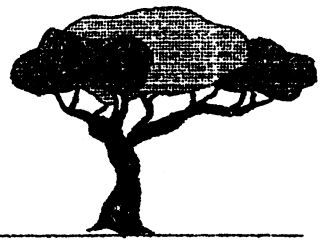
June 1990 saw the implementation of a forest resource monitoring system throughout New England. This long term effort to determine the health of our forests found New Hampshire with thirty-seven plot locations. Measurements are taken on an annual basis if change is expected to occur each year, such as the crown foliage density. Characterization of the soil for example, will be taken periodically, but on a longer cycle. Objectives include characterizing forest conditions, major stress factors, quantifying changes, and analyzing those changes which affect the growth, vigor and conditions of our forest resources (Brooks 1991).

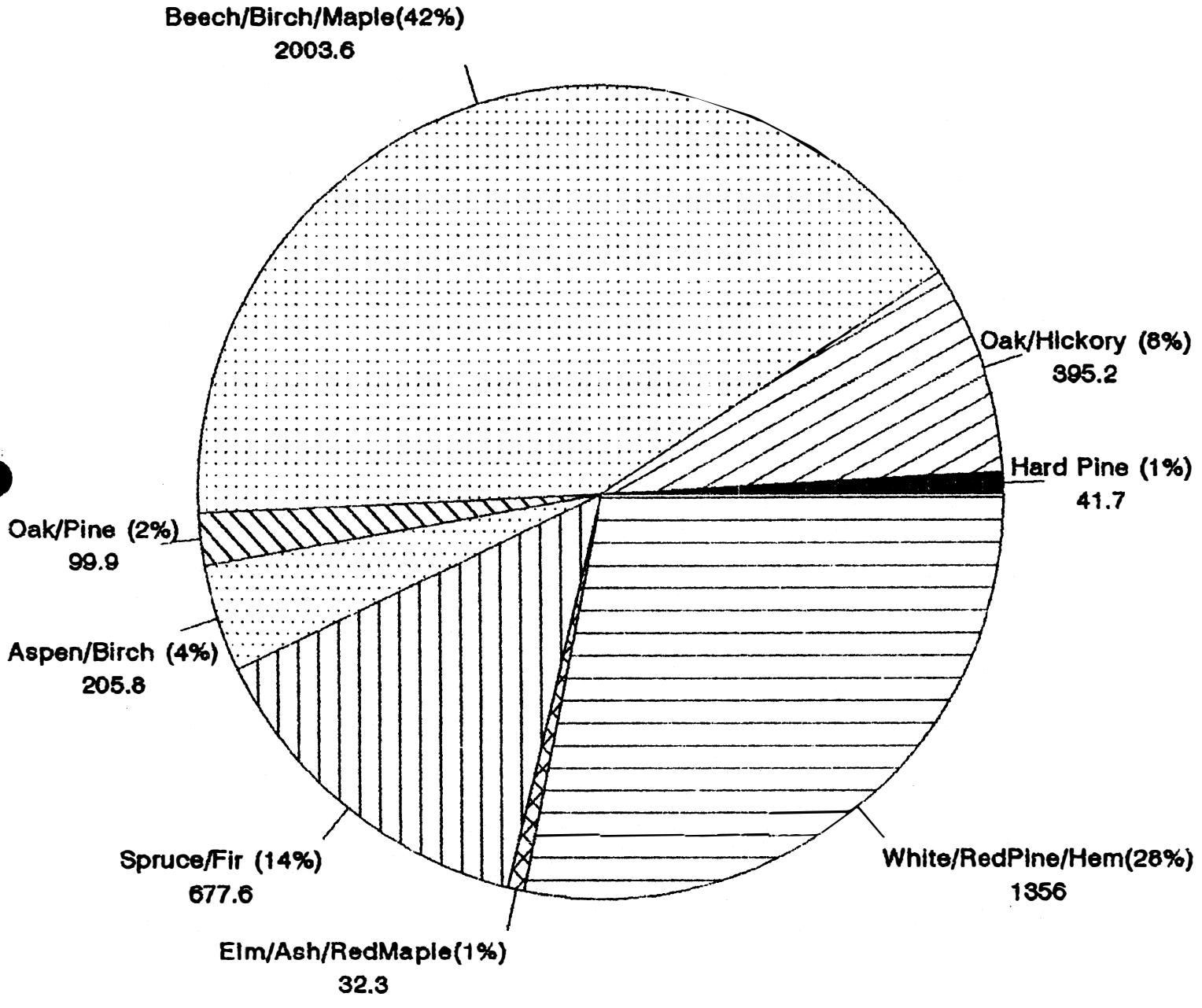
[1] Reflect only those species sampled south of the WMNF

This forest health monitoring effort is a cooperative undertaking involving participating states, the U.S. Forest Service and the U.S. Environmental Protection Agency.

During the last 20 years the responsibilities of the Division of Forests and Lands Forest Insect and Disease Unit have grown from protecting a single tree species from a single disease; like Blister Rust on white pine. Today the unit monitors the health of all our forest types and provides available protection to any of them whenever they may be threatened by adverse agents.

Fig.1: AREA OF TIMBERLAND BY FOREST TYPE- NEW HAMPSHIRE





Values shown in thousands of acres

INSECTS/DISEASE AND THEIR HOST FOREST TYPE
X=Preferred o=less preferred,but will occupy

	WP/RP	Spruce /Fir	Hard Pine	Oak/Pine	Oak/Hick	Elm/Ash /Red Maple	Beech Birch Maple	Aspen Birch
WPBR	X			o				
WPWeevil	X			o				
Ozone	X			o				
Annosus Root Rot	X			o				
Hemlock Looper	X	o						
Spruce Budworm		X						
European Spruce Sawfly		X						
Pine Needle Miner			X					
Gypsy Moth	X			X	X	o	o	o
Hardwd. Decline				X	X	X	X	X
Saddled Prom.							X	
Forest Tent							o	o
Eastern Tent							o	o
Bruce Spanworm							X	o
Beech Bark D.							X	
Pear Thrip							X	

WPBR = White Pine Blister Rust
WPWeevil = White Pine Weevil

Appendix 1 - Common and Scientific Names

Tree Species	Scientific Name
American basswood	Tilia americana L.
American beech	Fagus grandifolia Ehrh.
American chestnut	Castanea dentata (Marsh.) Borkh
American elm	Ulmus americana L.
Atlantic white cedar	Chamaecyparis thyoides (L.) B.S.P.
Balsam fir	Abies balsamea (L.) Mill.
Bigtooth aspen	Populus grandidentata Michx.
Bitternut hickory	Carya cordiformis (Wangenh.) K.Koch
Black ash	Fraxinus nigra Marsh.
Black cherry	Prunus serotina Ehrh.
Black locust	Robinia pseudoacacia L.
Black oak	Quercus velutina Lam.
Black spruce	Picea mariana (Mill.) B.S.P.
Black walnut	Juglans nigra L.
Butternut	Juglans cinerea L.
Chestnut oak	Quercus prinus L.
Dogwood	Cornus spp.
Eastern cottonwood	Populus deltoides Bartr.ex Marsh.
Eastern hemlock	Tsuga canadensis (L.) Carr.
Eastern redcedar	Juniperus virginiana L.
Eastern white pine	Pinus strobus L.
Gray birch	Betula populifolia Marsh.
Green ash	Fraxinus pennsylvanica Marsh.
Jack pine	Pinus banksiana Lamb.
Northern red oak	Quercus rubra L.
Northern white-cedar	Thuja occidentalis L.
Norway spruce	Picea abies(L.)Karst.
Paper birch	Betula papyrifera Marsh.
Pignut hickory	Carya glabra (Mill.) Sweet
Pin cherry	Prunus pensylvanica L.f.
Pitch pine	Pinus rigida Mill.
Quaking aspen	Populus tremuloides Michx.
Red maple	Acer rubrum L.
Red pine	Pinus resinosa Ait.
Red spruce	Picea rubens Sarg.
River birch	Betula nigra L.
Sassafras	Sassafras albidum (Nutt.) Nees
Scarlet oak	Quercus coccinea Muenchh.
Serviceberry(Shadbush)	Amelanchier spp. Medic.
Shagbark hickory	Carya ovata (Mill.) K.Koch
Silver maple	Acer saccharinum Marsh.
Sugar maple	Acer saccharum Marsh.
Sweet birch	Betula lenta L.
Sweetgum	Liquidambar styraciflua L.
Sycamore	Platanus occidentalis L.
Tamarack	Larix laricina (Du Roi)K.Koch
White ash	Fraxinus americana L.

White oak	*Quercus alba* L.
White spruce	*Picea glauca* (Moench) Voss
Willow	*Salix* spp. L.
Witch-hazel	*Hamamelis* spp. L.
Yellow birch	*Betula alleghaniensis* Britton
Yellow poplar	*Liriodendron tulipifera* L.

Insect Species	Scientific Name
Balsam woolly adelgid	*Adelges piceae* (Ratzeburg)
Beech scale	*Cryptococcus fagisuga* Lindinger
Bronze birch borer	*Agrilus anxius* Gory
Bruce spanworm	*Operophtera bruceata* (Hulst)
Cherry scallop-shell moth	*Hydria prunivorata* Ferguson
Eastern spruce beetle	*Dendroctonus rufipennis*(Kirby)
Eastern tent caterpillar	*Malacosoma americanum* (Fabriciusa)
European pine sawfly	*Neodiprion sertifer* (Geoffroy)
Fall webworm	*Hyphantria cunea* (Drury)
Forest tent caterpillar	*Malacosoma disstria* Hubner
Gypsy moth	*Lymantaria dispar* (L.)
Hemlock looper	*Lambdina fiscellaria* (Guen.)
Hemlock woolly adelgid	*Adelges tsugae* Annand
Oak leaftier	*Croesia semipurpurana* (Kearf.)
Pear thrips	*Taeniothrips inconsequens* (Uzel)
Pine needleminer	*Exoteleia pinifoliella* (Chambers)
Red pine beetle	*Ips pini* (Say)
Saddled prominent	*Heterocampa guttivitta* (Walker)
Spruce budworm	*Choristoneura fumiferana* (Clemens)
White pine weevil	*Pissodes strobi* (Peck)

Disease	Causal Organism
Annosum root rot	*Heterobasidion(Fomes)annosum(Fries)Berf.*
Armillaria	*Armillaria mellea* Vahl. ex Fr.
Beech bark disease (complex)	*Nectria coccinea* var. *faginata* Loh.,Wats., & Ay.
Chestnut blight	*Endothia parasitica* (Murr.)P.J.&H.W.Anderson
Dutch elm disease	*Ceratocystis ulmi* (Buism.) C. Mor.
Hypoxylon canker	*Hypoxlon mammatum* (Wahl.) Miller
White pine blister rust	*Cronartium ribicola* Fisch.

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